Particulate Settling Velocity

For particles falling at constant speed w under gravity, balancing drag, weight and buoyancy gives

$$c_D(\tfrac{1}{2}\rho w^2 A) = (\rho_p - \rho) g V$$

For spherical particles (or defining an equivalent diameter $d = \frac{3}{2}\frac{V}{A}$) this can be rearranged into the non-dimensional form

$$c_D \, \mathrm{Re}^2 = \frac{4}{3} d^{*3} \quad (1)$$

where

$$\mathrm{Re} \equiv \frac{wd}{\nu}, \qquad d^* = d\left[\frac{(s-1)g}{\nu^2}\right]^{1/3}, \qquad s = \frac{\rho_p}{\rho}$$

For Stokes particles (Re « 1):

$$c_D = \frac{24}{\mathrm{Re}} \quad (2)$$

Empirical fit of Schiller and Naumann, 1933, (for $\mathrm{Re}_s < 800$):

$$c_D = \frac{24}{\mathrm{Re}}(1 + 0.150\,\mathrm{Re}^{0.687}) \quad (3)$$

Empirical fit of Chen (1997) for natural grains (shape factor 0.5 – 0.7):

$$\mathrm{Re} = \left[(25 + 1.2 d^{*2})^{1/2} - 5\right]^{3/2} \quad (4)$$

The last of these is used on the web page.

Variables

- c_D = drag coefficient
- w = settling velocity
- d = particle diameter
- A = particle projected area
- V = particle volume
- ρ_p = particle density
- ρ = fluid density
- s (= ρ_p/ρ) = relative density
- g = acceleration due to gravity
- ν = kinematic viscosity
- Re_s = Reynolds number based on settling velocity and particle diameter

References

Cheng, N.-S., 1997, A simplified settling velocity formula for sediment particles, ASCE J. Hydraulic Engineering, 123, 149-152.